

Takashi MIKAWA*: A taxonomic study on Japanese
sporangiferous Mucorales (3)**

三川 隆*: 日本産胞子囊性ケカビ目菌類の分類学的研究 (3)**

Thamnidiaeae Brefeld, Bot. Unters. Schimmelpilze 4: 161 (1881).

Sporangiophores arising from substrate mycelia or stolons opposite the rhizoids. Sporangia present or absent, if present, columellate, apophysate or not apophysate, deliquescent or dehiscent at maturity; both sporangia and sporangiola or monosporous sporangiola usually borne on the same sporangiophores. Sporangiola or monosporous sporangiola usually borne on lateral branchlets of sporangiophores, with a persistent wall, detached by the breakdown of branchlets. Sporangiospores smooth. Zygospores globose to subglobose. Suspensors H-like.

Type genus: *Thamnidium* Link ex Wallroth

Traditionally the Thamnidiaeae has been characterized by the presence or absence of large, many spored, columellate sporangia and the presence of sporangiola which contain one to a few spores and in most cases lack columella, but rarely possess rudimentary one (Lendner, 1908; Zycha, 1935; Hesseltine, 1955; Zycha *et al.*, 1969; Hesseltine & Ellis, 1973).

Nevertheless, because of the absence of distinct definition between sporangium and sporangiolum, some confusions have occurred in the taxonomy of the sporangiiferous Mucorales. For example, *Dicranophora* has been placed in the Thamnidiaeae (Lendner, 1908; Zycha, 1935; Zycha *et al.*, 1969), while the genus has been retained in the Mucoraceae (Hesseltine, 1955; Tandon, 1968; Benny & Benjamin, 1975). *Backusella* was originally placed in the Mucoraceae by Ellis & Hesseltine (1969), but recently, this genus has been transferred to the Thamnidiaeae (Pidoplichko & Milkko, 1971; Benny & Benjamin, 1975). *Mucor lamprosporus*, *Circinella linderi* and *Pirella circina* were transferred to the Thamnidiaeae on the basis of the presence of both sporangium

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** Continued from Journ. Jap. Bot. 54: 5-14 (1979).

and sporangiolum (Benny & Benjamin, 1975).

In the present study, sporangium is distinguished from sporangiolum by the following points: in case of that spores are released, spore-sac being not detached from the sporangiophore even after release of spores is sporangium. While, sporangiolum may be detached from the sporangiophore. From this evidence, the manner of spore release can be used a character for distinguishing sporangium from sporangiolum and the Thamnidiaeae is characterized by the presence of deciduous sporangiolum.

Therefore, *Backusella*, *Helicostylum*, *Thamnidium* and *Thamnostylum* are included in the Thamnidiaeae, while *Dicranophora* and *Mucor lamprosporus* are treated as a member of the Mucoraceae in the present paper.

On the taxonomic position of *Chaetocladium*, Brefeld (1881) took up the presence of "conidia" as a taxonomic criterion to separate families and established the Chaetocladiaceae. However, it is known by many mycologists that "conidia" of *Chaetocladium* possess a distinct sporangiolar wall. From this fact, Zycha (1935) combined the Chaetocladiaceae with the Thamnidiaeae and broadened the limitation of the Thamnidiaeae to include *Chaetocladium*. In the presence of monosporous sporangiola only, this genus is similar to the members of the Cunninghamellaceae, but it appears desirable to retain *Chaetocladium* in the Thamnidiaeae because of the absence of head vesicles and having sterile spines as seen in *Helicostylum*.

Approximately 10 genera have hitherto been known, of which the following five genera have been found in Japan.

Key to genera of the Thamnidiaeae

1. Sporangia and sporangiola lacking. Only monosporous sporangiola present *Chaetocladium*
1. Sporangia present or absent. Sporangiola or monosporous sporangiola present 2
2. Rhizoids and stolons present. Columellae apophysate *Thamnostylum*
2. Rhizoids and stolons absent. Columellae not apophysate 3
3. Lateral branchlets of sporangiola arising in whorls or in cluster from main sporangiophores 4
3. Lateral branchlets of sporangiola and monosporous sporangiola arising singly from main sporangiophores *Backusella*

4. Lateral branchlets either unbranched, ending into sporangiola or branched in whorls; its branchlets ending into sporangiola or sterile spines.....

..... *Helicostylum*

4. Lateral branchlets unbranched or branched dichotomously; its branchlets ending into sporangiola, without sterile spines..... *Thamnidium*

Backusella Hesseltine et Ellis, Mycologia 61: 863 (1969).

Rhizoids and stolons absent. Sporangiophores arising from substrate mycelia, ending into a terminal sporangium. Sporangia globose to subglobose. Branchlets of sporangiola or monosporous sporangiola arising singly from main sporangiophores or substrate mycelia, straight or circinate. Sporangiola and monosporous sporangiola globose. Zygospores verrucose. Suspensors lacking appendages.

Type species: *Backusella circina* Ellis et Hesseltine

Two species have been hitherto known. Only one species has been found in Japan.

Backusella circina Ellis et Hesseltine, Mycologia 61: 865 (1969).

Mucor pseudolamprosporus Naganishi et Hirahara, Bull. Hiroshima Jogakuin Coll. 18: 169 (1968), nomen nudum.

Illust.: Naganishi, H. & S. Hirahara. 1968. Pl. I-III; Tubaki, K. 1973. Pl. I, figs. A-C; figs. 1, a-f.

Colonies on LCA incubated at 20°C for a week hyaline, 1.5 cm high. Vegetative hyphae up to 15 μm wide, hyaline. Gemmae not observed. Sporangiophores 7.5-15.4 μm wide, hyaline, septate, at first recurved and unbranched, later straight and branched. Sporangia 25-75 μm wide, hyaline to light brown. Sporangial walls hyaline, spiny. Columellae applanate to broad ovoid or dome-shaped, 10-38.8 μm long, 13-38 μm wide, with a indistinct collar, slightly constricted at the base. Branchlets of sporangiola and monosporous sporangiola 4.6-7 μm wide, hyaline, septate, circinate, unbranched or branched sympodially. Sporangiola rarely present, 16.9-25 μm in diam., hyaline, spiny. Monosporous sporangiola 7.7-19.2 μm in diam., dark yellowish brown, echinulate. Sporangiospores from sporangia and sporangiola globose to subglobose, rarely short ovoid, 6.6-14 \times 6.3-12.5 μm , hyaline to pale yellow. Zygospores not observed.

Hab. and Loc. coll.: from fallen flowers, Kawaguchi, Saitama Pref. (Mikawa-no. 935); soil, Koishikawa Botanical Gardens, Tokyo (Mikawa-no. 919);

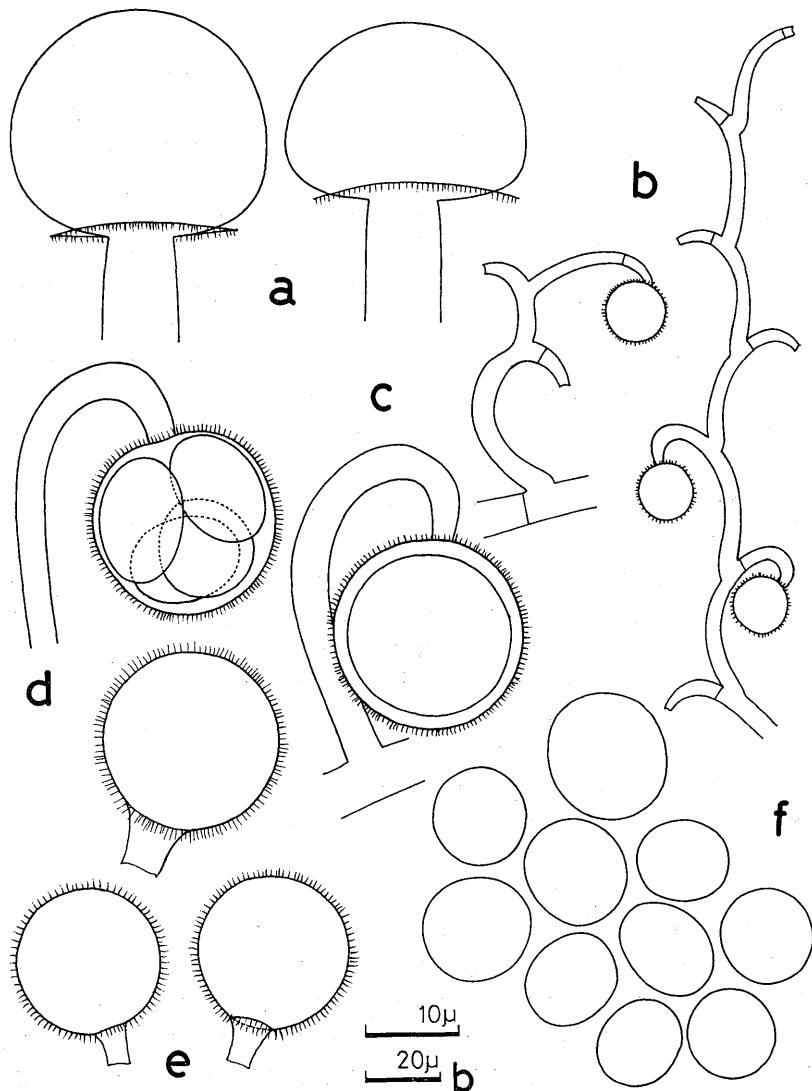


Fig. 1. *Backusella circina*. a. Columellae. b. Circinate branchlets left after detachment of monosporous sporangiola. c. Monosporous sporangium containing one spore. d. Sporangium containing four spores. e. Detached monosporous sporangiola. f. Sporangiospores.

forest soil, Ryuga-do, Kochi Pref. (Mikawa-no. 741); humus kindly collected by Dr. Koichiro Miura in Kuromi, Yaku Isl. (Mikawa-no. 673); forest soil collected by Dr. Koichiro Miura in Mt. Omoto-dake, Ishigaki Isl. (Mikawa-no. 316); decaying bark, dead insect and mushroom, Tottori Pref. (Naganishi, H. & S. Hirahara. 1968 as *Mucor pseudolamprosporus* Naganishi et Hirahara); embedded sterilized leaves of *Castanopsis*, Shiga Pref. (Tubaki, K. 1973).

Zygospores were originally found by Ellis & Hesseltine (1969).

The present isolates agreed with the original description. This species is characterized by the following morphological features: 1) main sporangiophores circinate at first, becoming straight later, 2) sporangiospores globose to subglobose in shape, 3) columellae applanate to broad ovoid or dome-shaped, 4) sporangiola and monosporous sporangiola borne usually on circinate lateral branchlets, 5) sporangiolar walls of monosporous sporangiola thick, brownish in color, with long spines as seen in *Cunninghamella echinulata*.

Naganishi & Hirahara (1968) isolated a new species of *Mucor* and named it *M. pseudolamprosporus*. According to them, this species is characterized by the presence of monosporous sporangiola (called pseudosporangiola by them) borne on the lateral circinate branchlets. In 1974 von Arx treated this species as a synonym of *Backusella circina*, without any discussion. Judging from the description and illustrations given by Naganishi & Hirahara (1968), I followed von Arx in this paper.

On the other hand, when Naganishi & Hirahara (1968) described *M. pseudolamprosporus* they did not give a Latin diagnosis. According to Article 36 of the International Code of Botanical Nomenclature, the name was not validly published.

Chaetocladium Fresenius, Beitr. Mykol. 97 (1863).

Aerial mycelia creeping, when parasitic, producing gall-like structures. Rhizoids and stolons absent. Sporangiophores arising singly from aerial mycelia, repeatedly branched in whorls; the ultimate branches ending into monosporous sporangiola; the central axis of each whorl ending into sterile spines. Sporangia and sporangiola always absent. Monosporous sporangiola borne on denticles of a node. Zygospores verrucose. Suspensors lacking appendages.

Type species: *Chaetocladium jonesii* (Berkerley et Broome) Fresenius

Two species have been hitherto known, and have been found in Japan.

Key to species

1. Monosporous sporangiola 6.5-10 μm in diam., echinulate *C. jonesii*
1. Monosporous sporangiola 4.4-6.0 μm in diam., smooth *C. brefeldii*
- 1) ***Chaetocladium brefeldii*** van Tieghem et Le Monnier, Ann. Sci. Nat. Bot. V, 17: 342 (1873).

Chaetocladium brefeldii van Tieg. et Le Monn. var. *macrosporum* Burgeff, Bot. Abhand. 1: 109 (1920).

Illust.: Saito, K. & Y. Okazaki. 1938. Pl. II, fig. 1; figs. 2, a-d.

Colonias on LCA incubated at 20°C for a week light olive gray, 3 mm high. Vegetative hyphae up to 11.5 μm wide, hyaline. Gemmae not observed. Aerial mycelia at first non septate, later septate, sometimes adventitiously septate, branched. Sporangiophores 10-26 μm wide, hyaline, at first non septate, later septate, sometimes adventitiously septate. Monosporous sporangiola

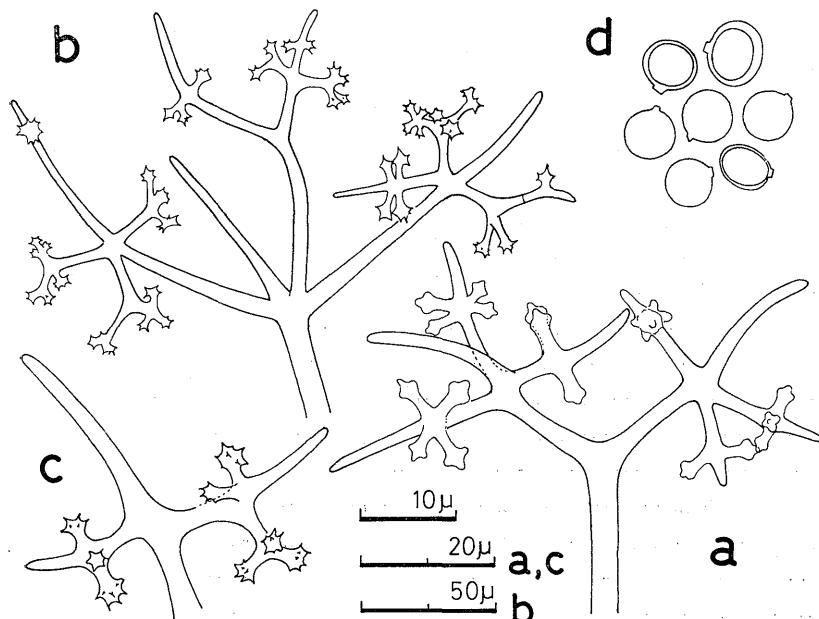


Fig. 2. *Chaetocladium brefeldii*. a. Portion of a sporangiophore. b, c. Portion of a sporangiophore, showing branchlets left after detachment of monosporous sporangiola. d. Monosporous sporangiola.

globose to subglobose, $5-7 \times 4.4-6.0 \mu\text{m}$, hyaline to pale yellow, smooth. Zygospores not observed.

Hab. and Loc. coll.: from rat dung, Sapporo, Hokkaido (Mikawa-no. 882); rat dung, Suginami, Tokyo (Mikawa-no. 213); mouse dung, Sugadaira, Nagano Pref. (Mikawa-no. 76); soil, Sugadaira, Nagano Pref. (Lee, Ji-Yul. 1972); air, Osaka (Saito & Okazaki. 1938 as *C. brefeldii* var. *macrosporum* Burgeff).

Zygospores have been found by many mycologists.

The present isolates agreed with the original description. This species is distinguished from *C. jonesii* by the small sporangiola and smooth walls.

2) **Chaetocladium jonesii** (Berkeley et Broome) Fresenius, Beitr. Mykol. 97 (1863).

Botrytis jonesii Berkeley et Broome, Ann. Mag. Nat. Hist. II, 13: 462 (1954)—*Chaetocladium fresenianum* Brefeld, Bot. Unters. Schimmelpilze 4: 55 (1881)—*C. fresenii* Tavel, Verg. Morph. Pilze 36 (1892).

Illust.: Saito, K. 1904. Pl. IV, figs. 27.

Hab. and Loc. coll.: from air, Tokyo (Saito, K. 1904).

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Thamnidiaeae と Mucoraceae は小胞子嚢をもつか、胞子嚢をもつかが從来分類上の重要な識別点とされていた。しかし、小胞子嚢と胞子嚢の形態的差異については必ずしも明確な定義がなく、このため、ある属たとえば *Backusella* 属や *Dicranophora* 属の分類上の帰属は論議の焦点でもあった。本論文では、胞子が分散する際に、脱落する器官を小胞子嚢、脱落しないで残存するものを胞子嚢と定義することにより *Backusella* 属を Thamnidiaeae に、*Dicranophora* 属を Mucoraceae に所属させることが妥当であると結論した。

○ *Knowltonia bracteata* Harv. (キンポウゲ科)の核型. (岡田 博) Hiroshi OKADA: Karyotype of *Knowltonia bracteata* Harv. (Ranunculaceae).

Knowltonia 属はキンポウゲ亜科に属し、イチリンソウ属に近縁の植物で、アフリカ南部にのみ分布している。*Knowltonia* 属の細胞学的報告は1932年に Langlet (Svensk Bot. Tidskr. 26: 391) によって行なわれただけである。この報告には写真もスケッチもなく、ただ *K. vesicatoria* は $2n=48$ で、R 型の染色体 (大型の染色体) を持つことが記されているだけで、詳細なことは何も記されていない。

今回、核型の観察に用いた *K. bracteata* は Royal Botanic Garden, Edinburgh (南アフリカ, Natal, Lion's River Dist., Dargle, Burtt 氏採集) より送られた種子を発芽させたもので、根端を用いて染色体を観察した。なお観察方法、顕微鏡写真は Okada & Tamura (本号65-77頁) を参照してほしい。

染色体数は $2n=48$ であった。大きさは最大約 8μ 、最小約 4μ で、イチリンソウが $12-8\mu$ であるのに比べ、かなり小さい。図はこれらの染色体を並べたもので、大きさ、形、付随体の有無などから 6 本ずつの 8 組に分けられた。このことから、本種の基本数は $x=8$ で、その 6 倍体であることが推定される。この $x=8$ はイチリンソウ属の基本数 $x=7, 8$ のうちの一方と同じである。また $x=8$ をもつイチリンソウ属の核型 (Kurita 1957 Rep. Biol. Inst. Ehime Univ. 1: 1-10) と比較してみると、各組の染色体の形はよく似ている。

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Knowltonia bracteata ($2n=48$) is a hexaploid of basic chromosome number, $x=8$. The basic chromosome set is similar to that of $x=8$ series of *Anemone*, $\times 2000$.